

# Partha Niyogi

## July 31, 1967 - October 1, 2010

It is with great sadness that we announce the passing of our dear friend and wonderful colleague, Partha Niyogi, who died on October 1, 2010, at the age of 43, after a year-long struggle with cancer.

He was the Louis Block Professor of Computer Science and Statistics at the University of Chicago, where he had been on the faculty since 2000. He was admired by all who knew him for the incisiveness of his mind and for his ability to ask key questions and connect distant areas. The breadth and depth of his thinking, his sound judgment in matters of science and organization, his seemingly limitless energy, and his warmth and human kindness earned him the respect and the trust of his colleagues. He was an inspiring teacher and a caring mentor for his students.

Partha was born in Calcutta (Kolkata) and grew up in Bombay (Mumbai). His father was a scientist working in industry, and his mother a schoolteacher. Partha finished his high school in New Delhi, where he then went on to study electrical engineering as an undergraduate at the Indian Institute of Technology. He wrote a thesis on the automatic recognition of beats on the Indian instrument tabla, a project that drew him to the study of perception, recognition, and learning, as well as acoustics, music, and language. In the fall of 1989 he entered the graduate program at the Massachusetts Institute of Technology, where he worked on speech recognition and learning theory, and interacted not only with computer scientists, but linguists and cognitive scientists more generally. He earned his Ph. D. in 1995 under Tomaso Poggio. After a brief postdoctoral stay at MIT, he became a member of the technical staff at Bell Laboratories in Murray Hill, New Jersey. In 2000, he accepted an offer from the Department of Computer Science at the University of Chicago, and shortly thereafter joined the Department of Statistics as well.

Partha married economist Parvati Krishnamurty in 1995. Their twin sons Nikhil and Kabir were born in Chicago in October 2002. Parvati works for the National Opinion Research Center at the University of Chicago.

## Career

Partha's interests spanned a broad spectrum. He was a scientist, a computer scientist, and a mathematician. He recognized and studied the computational nature of natural phenomena and the mathematical nature of computational objects. Always ready to challenge conventional wisdom, he built new models, and applied his strong mathematical intuition and analytic techniques to them. His vision and technical power helped reshape the landscape of much-studied areas like data analysis, speech recognition, and language development.

A major line of Partha's research was geometrically based methods for inferring hidden patterns from complex sets of data. In many problems, the observed data are scattered in a space of high dimension. But implicit structure in the data (or the system that gave rise to the data in the first place) will often lead to data actually residing on, or near, a surface of much lower dimension. Being able to characterize that submanifold is a big step toward understanding the data. Partha's key insight was to see the connection between a class of spectral methods and mathematical properties of unknown submanifolds, in particular their Laplace-Beltrami operators. Based on this idea, Partha made fundamental contributions to the field of data analysis. Methods developed in his work emerged as important algorithmic tools and have already been applied to a range of real-world problems, from image recognition to the analysis of spoken language.

Motivated by this work, Partha made significant contributions to the theory of computing by designing polynomial-time algorithms to compute the surface area of a convex body in high dimension, and to sample from such a surface, relying, remarkably, on the heat equation, linking the surface area to the heat dissipation rate of the body.

Partha's deep interest in language and learning included a keen desire to better understand the computational principles of human speech communication. At the center was the long-standing mystery of robust human speech perception: how do humans recognize speech produced by speakers of all shapes and sizes in extremely noisy conditions? Robust speech per-

ception is a cognitive task that humans perform with relative ease, while automatic speech recognition systems still struggle in even mildly adverse environments. Partha was a strong proponent of returning to the science behind human speech production and perception for the inspiration to engineer a new generation of speech recognition technology. With this motivation, he developed novel acoustic representations and models derived from his broad knowledge of physics, linguistics, and neuroscience.

Another major line of Partha's research, culminating in his 2006 book, *The Computational Nature of Language Learning and Evolution*, was the computational and mathematical study of language evolution, on both historical and evolutionary timescales. Each child normally acquires the language of his or her community very accurately. If acquisition were always successful, languages would never change. Yet all languages do, sometimes quite drastically. Why and how does language change occur? Drawing on techniques from learning theory and nonlinear dynamics, Partha developed a computational framework to understand the relationship between language learning at the individual level and the evolutionary dynamics of the community's language over historical time, described by a dynamical system. He found these dynamics were typically highly nonlinear, and explored how they were affected by assumptions about individual learning – such as whether children learn only from parents, or from the community as a whole – in models of changes from the history of English, Chinese, French, and Portuguese. A fundamental insight of this work was that major changes in the history of a language could be understood as bifurcations (phase transitions) in its dynamical system: the language shifts from one stable state to another as the result of a minor drift in usage frequency across a critical threshold. Such bifurcations offer a solution to the recalcitrant actuation problem: what is it that initiates language change? On an evolutionary timescale, Partha explored the conditions which must hold for a stable, shared communication system to evolve in a population. His work in these areas has been influential in the fields of language evolution and historical linguistics.

Partha recently embarked on a major new direction of research: automated detection of speech-related disorders. His paper, “Automated vocal analysis of naturalistic recordings from children with autism, language-delay, and typical development,” written with coauthors, appeared in the July 2010 issue of the *Proceedings of the National Academy of Science*.

## Memoriam

In April 2010, during the tenth month of his struggle with his relentlessly progressing condition, Partha gave a compelling lecture at the Department, weaving together ongoing research in multiple broad areas in a monumental tapestry that left the audience awestruck.

Partha's passing leaves an emptiness in our hearts and a hole in the fabric of Computer Science in Chicago.

Partha is survived by his wife Parvati Krishnamurty, their young children Nikhil and Kabir, Partha's parents Ranjit and Prabhati Niyogi, and his brother Siddhartha Niyogi.

A memorial service will be held at the University of Chicago's Bond Chapel at 2pm on Saturday, October 30, 2010.